

Final Technical Report

for

**Turbine Internal and Film Cooling Modeling
For 3D Navier-Stokes Codes**

**NASA Grant Number
NCC3-926**

**Grant Duration
December 6, 2001 to April 30, 2005**

Dr. Kenneth DeWitt
Principal Investigator

Vijay Garg and Ali Ameri
Co-Principal Investigators

**Department of Mechanical, Industrial and Manufacturing Engineering
University of Toledo
Toledo, Ohio 43606**

May 2005

Objectives of Research

The aim of this research project is to make use of NASA Glenn on-site computational facilities in order to develop, validate and apply aerodynamic, heat transfer, and turbine cooling models for use in advanced 3D Navier-Stokes Computational Fluid Dynamics (CFD) codes such as the Glenn-HT code. Specific areas of effort include:

- Application of the Glenn-HT code to specific configurations made available under Turbine Based Combined Cycle (TBCC), and Ultra Efficient Engine Technology (UEET) projects.
- Validating the use of a multi-block code for the time accurate computation of the detailed flow and heat transfer of cooled turbine airfoils.

The goal of the current research is to improve the predictive ability of the Glenn-HT code. This will enable one to design more efficient turbine components for both aviation and power generation.

The models will be tested against specific configurations provided by NASA Glenn.

Accomplishments

Vijay Garg

Completed computation of internal heat transfer in the trailing edge part of the real industrial blade, and compared with experimental data from the industry. Also, prepared an internal NASA report on the results obtained.

Started computation of flow characteristics and heat transfer for the GE Aircraft Engines Revolutionary Turbine Accelerator centerbody and augmentor using the Glenn-HT code. Presently, calculations are being carried out for the YF120 design for a cooled and uncooled centerbody. Computations have been completed for the baseline case with uniform inlet profiles (no swirl), and also for inlet profiles as provided by GE for the stagnation pressure and temperature as well as swirl. Future work will include modeling the 2006 Ground-based Testbed geometry, which is still under development.

Ali Ameri

The tasks that performed include:

The Glenn-HT code was run to predict the pressure distribution on the GE-E³ blade. This was done to prepare instrumentation for an experiment on the blades in CW-22 test cell.

Dr. Ameri added subroutines to the GlennHT-2000 code to allow for the performance of film-cooling calculations. Added a subroutine and modified another to allow specification of inlet angles and inlet boundary layer thickness for turbine flows. Dr. Ameri wrote several subroutines to allow inlet and exit boundary conditions radial integration to be integrated into the rotor-stator interaction routines which are planned.

Dr. Garg's files were transferred and the grid topology adapted to the new format of the GridPro for future calculations.